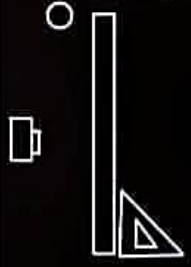
Ahsan Badhon

Unit-3

* Determining the value of g for free falling objects:

=> Set up apparatus:

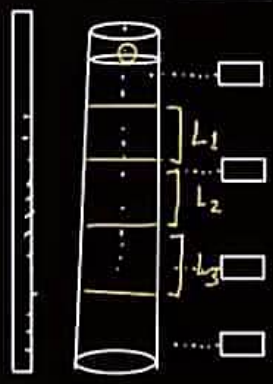


Explanation: Hold a metre rule vertically and perpendicular against a set square. Drop a spherical ball from a known height, s. Then measure the corresponding time, t, to reach the ground using slow motion camera. Then use the formula, $s = \frac{1}{2}gt^2$ to find the value of acceleration, which is, g. Repeat this experiment for range of heights and measure the corresponding time and calculate the average value of acceleration which should give us, g.

* Investigating the viscosity of the liquid using spherical balls:

$$V_{term} = \frac{2g(P_s - P_f)}{9\eta}$$

=> Set up apparatus:



$P_s = \frac{\text{Mass}}{\text{Volume}}$ → weighing machine

Volume → $\frac{4}{3}\pi r^3$ → vernier calliper / micrometer screw guage

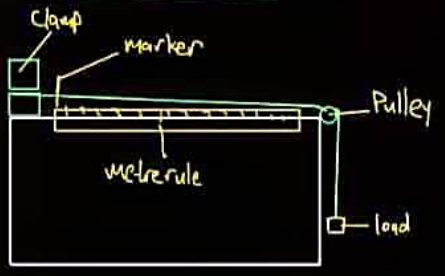
$P_f = \frac{\text{Mass}}{\text{Volume}}$ → weighing machine

Volume → volume in measuring cylinder

Explanation: Drop a ball from the surface of the liquid, using several light gates at equal distance intervals. The diameter of the ball is giving us the distance for which the light gate is under shadow, the light gate will give us the time taken for the ball to pass through it. We can calculate the velocity at each light gate using the formula, $v = \frac{d}{t}$. The ball will reach terminal velocity when the calculated, V, remains constant. We then need to calculate the density of the ball using, $P_s = \frac{\text{Mass}}{\frac{4}{3}\pi r^3}$. The mass can be measured using weighing machine, and the diameter of the ball using vernier calliper, $r = \frac{d}{2}$. Then we need to calculate the density of the fluid, $P_f = \frac{\text{Mass}}{\text{Volume}}$. The mass can be measured using weighing machine and the volume shown in the measuring cylinder. Then at the end use the formula, $V_{term} = \frac{2g(P_s - P_f)}{9\eta}$, then subject the η which is the coefficient of viscosity.

*Determining the young modulus of a string:

» Apparatus set-up:



Base formula:

→ Young modulus = $\frac{\text{stress}}{\text{strain}}$

→ Stress = $\frac{\text{Force}}{\text{Area}}$ → Newton meter → πr^2 → vernier calliper

→ Strain = $\frac{Lf - Lo}{Lo}$ → metre rule

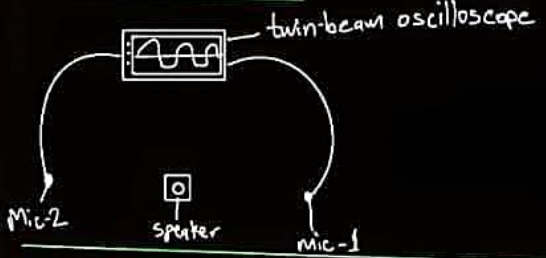
Explanation: Measure the force applied by the mass load using Newtonmeter, and its cross-sectional area of the string by measuring the diameter of it using micro-meter screwgauge or vernier calliper and using the formula, πr^2, where $r = \frac{d}{2}$. Then he needs to use the formula, stress = $\frac{\text{Force}}{\text{Area}}$ to calculate the stress.

Now to find the strain he needs to set-up the apparatus according to the diagram. Using a metre rule he can measure the original length, Lo without extending any mass to it. Then the final length, Lf, by adding each loads to it. Use the formula, $x = Lf - Lo$. He can then calculate the strain, using strain = $\frac{x}{Lo}$.

In the end, use young modulus = $\frac{\text{stress}}{\text{strain}}$ to calculate the young modulus of the string.

*Determine the speed of sound in air using twin-beam oscilloscope, signal generator, speaker and microphone:

→ Apparatus set up:



Base-Formula:

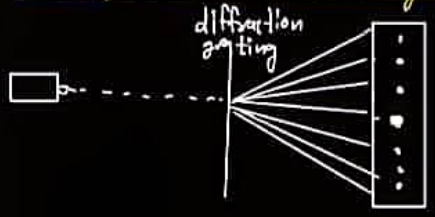
Path difference = wavelength

Oscilloscope → time period

wave speed = $\frac{D}{T} = \frac{\lambda}{T}$

Explanation: At first put the sound source equidistant from both the microphones and observe the oscillations. Then move one microphone far from the sound source until the oscillations are inphase to the first oscillation this shows a path difference of λ. Then measure the difference in distance of the 2 microphones from the sound source using metre rule and time from the difference in the peaks from the oscilloscope. Then use the formula, wave speed = $\frac{\text{distance}}{\text{Time}}$ to measure the speed of the sound.

* Determining the wavelength of light from a laser or other light source using a diffraction grating:



Base formula:

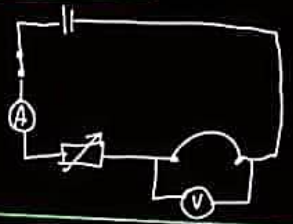
$n\lambda = d\sin\theta$

$\lambda = \frac{d\sin\theta}{n}$

Explanation: Project a laser on a diffraction grating, use the (n), for the number of order in the bright spots, measure the (θ) which is the angle between central bright and the nth order using a protractor. Measure the distance between the gaps using, $\frac{1}{\text{gratings/metre}}$. Then use the formula to find the wave length, $n\lambda = d\sin\theta$, so $\lambda = \frac{d\sin\theta}{n}$

* Determining the electrical resistivity of a material:

→ Apparatus set up:



Base formula:

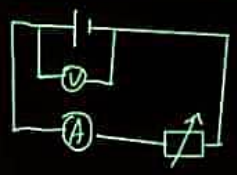
$R = \frac{\rho L}{A} \therefore \rho = \frac{RA}{L}$ — (I)

$R = \frac{V}{I}$ — (II)

* Explanation: Measure the diameter of the wire using micrometer screw gauge and then to calculate radius, $r = \frac{d}{2}$. Calculate the base area of the wire using the formula, Area = πr^2. For several lengths of the wire, calculate the resistance by measuring the voltage and current across the wire using, $R = V/I$. So for calculating resistivity (ρ), use $\rho = \frac{R \times A}{L}$.

* Determining the emf and Internal Resistance of an electrical cell:

* Apparatus set up:



Base formula: $\mathcal{E}mf = V_R + Ir$

* V_R = Voltage across the resistor
* $V_R = I \times R$
* r = Internal resistance

* Explanation: We can change the resistance in the variable resistor. Initially the resistance is kept high / maximum so that there is no current flowing through the circuit. Then slowly reduce the resistance in the variable resistor and measure the corresponding current and voltage. The voltage from the voltmeter, will give us the voltage drop in the battery from the initial value. Then using the formula, $\mathcal{E} = V_R + Ir$, to find the emf and internal resistance in the battery.

• Percentage uncertainty = $\frac{\text{uncertainty of the instrument}}{\text{Range of values}} \times 100$

• Criticizing results:

1) When less than 6 reading are taken → Too few reading/values are taken.
2) When decimal places of the values are not the same → Inconsistent decimal places.
3) When gap between readings are not the same → Inconsistent intervals for given value.
4) When dependent values are not repeated → Repeat readings should have taken by averaging the results.
5) When unit is absent → Unit is not given.
6) When 6 readings are taken but not widely range → Range of readings should be wider.

• Techiques of Measurement:

1) Uncertainty: A range of values which are likely to contain true value.
   Eg: uncertainty = $\frac{\text{Precision}}{2}$, ± 0.5mm in ruler.
2) Percentage uncertainty = $\frac{\text{uncertainty of the instrument}}{\text{Total range of measurement taken}} \times 100$
3) Accuracy: it is a measure of how much close the value are to the true value.
4) Reliability: When the experiment is repeated several times under same conditions, the values are still similar.
5) Zero error: An error that is caused when an instrument does not read the true zero.
6) Random error: An unpredictable error that has no pattern or bias. To reduce this error, repeat and take the mean value.
7) Systematic error: An error that has a pattern or a bias, this is due to the process of experiment or an error in apparatus. This error might add or substract the same value to each readings.
8) Parallax error: The error caused by human mistakes, reaction time.

Advantages of a graph:

1) Enables an average result to be taken via the line of best fit
2) Graphs identifies anomalies.
3) Allows trend to be identified.
4) Allows equation to be derived.
5) Systematic errors can be detected.
6) Allows extrapolation / intrapolation
7) Gives gradient / intercept / area under the graph.